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B60R 22/46

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B7B BVRP

(56) Documents Cited  
GB 2323769 A GB 2320469 A GB 2315986 A  
GB 2297238 A GB 2250418 A GB 2247392 A  
GB 2227642 A WO 97/39923 A1

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INT CL<sup>6</sup> B60R 22/46

(54) Abstract Title  
Buckle pretensioner for a vehicle

(57) A buckle pretensioner for a vehicle safety restraint comprises a buckle head 1 or receiving a buckle tongue to secure safety restraint webbing about a vehicle occupant in a three-point belt system; a cable 2 connected to the buckle head; and means for rapidly withdrawing the cable in a belt tightening direction, the withdrawing means comprising a force reservoir 9, and driving means 6-8, and being of a compact construction. The force reservoir may be a pyrotechnic gas generator 9 or a spring. Various alternative driving means are disclosed.

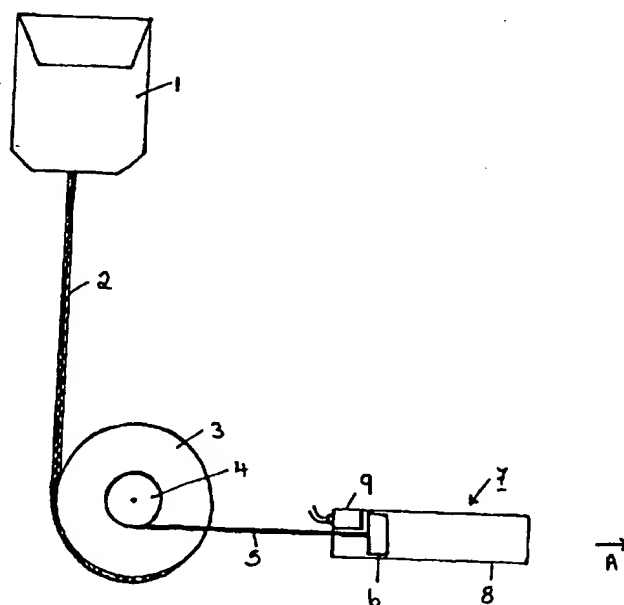


Figure 1

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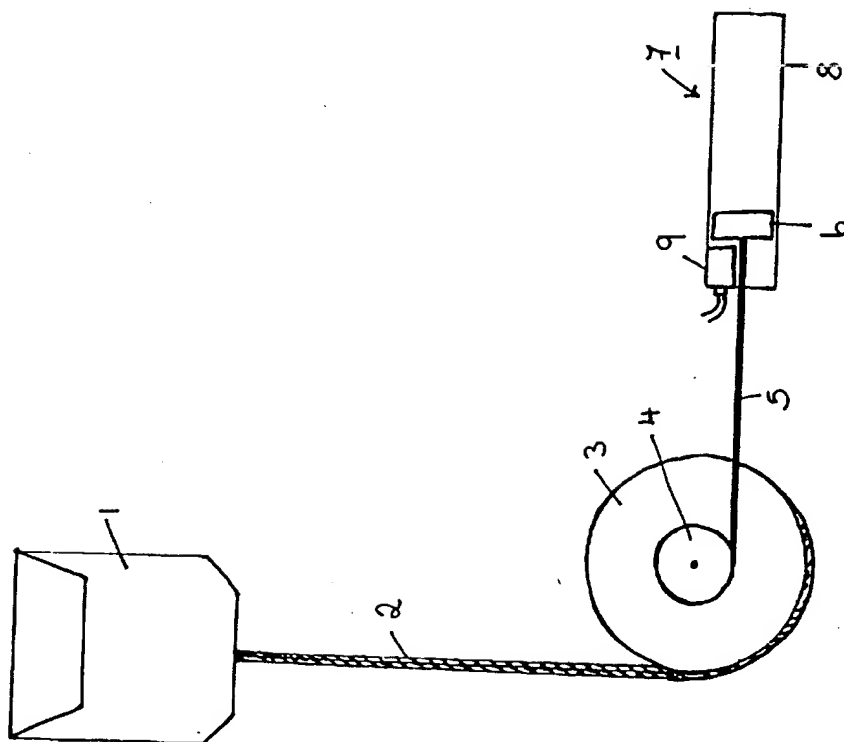


Figure 1

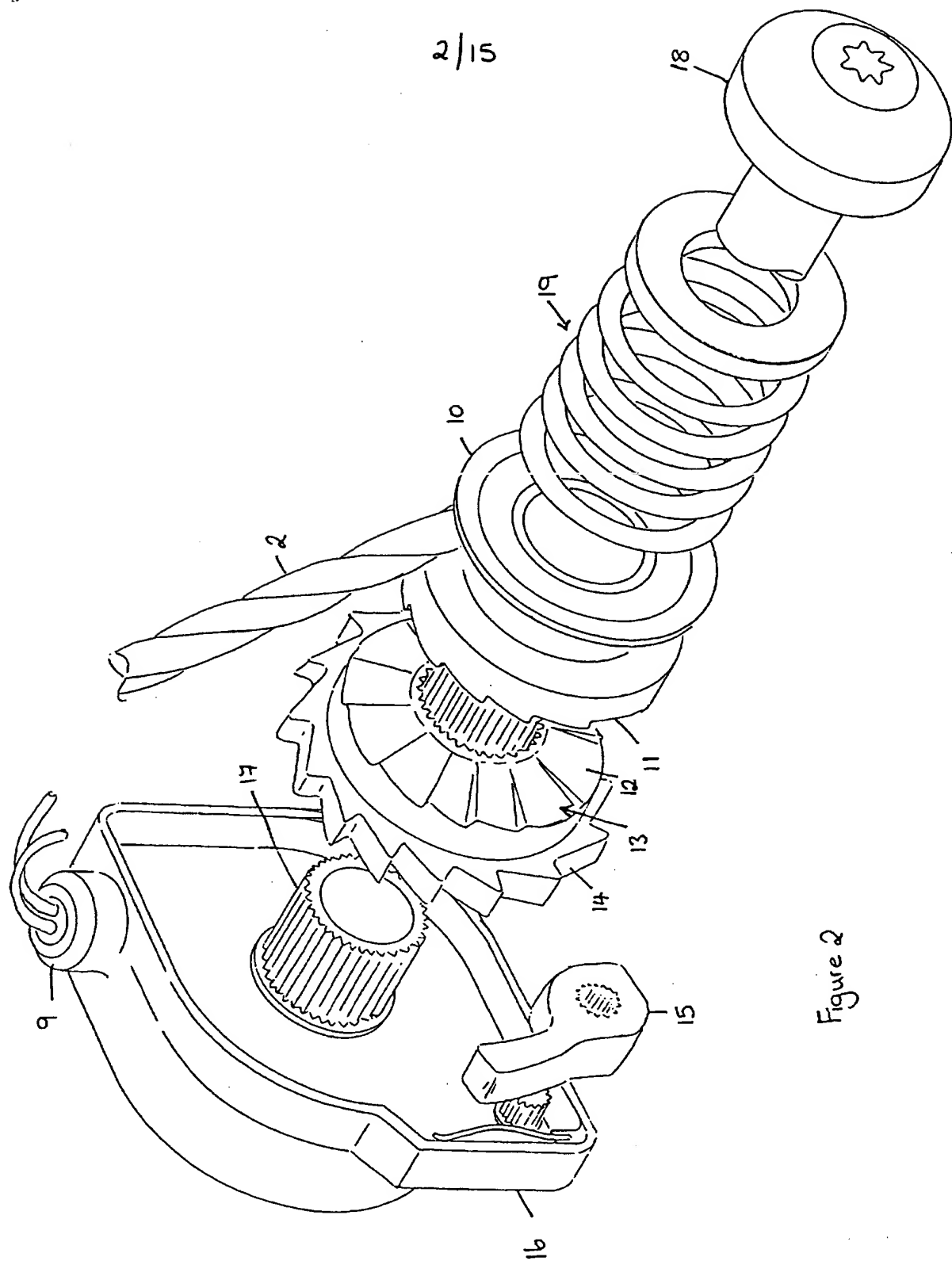


Figure 2

Figure 3

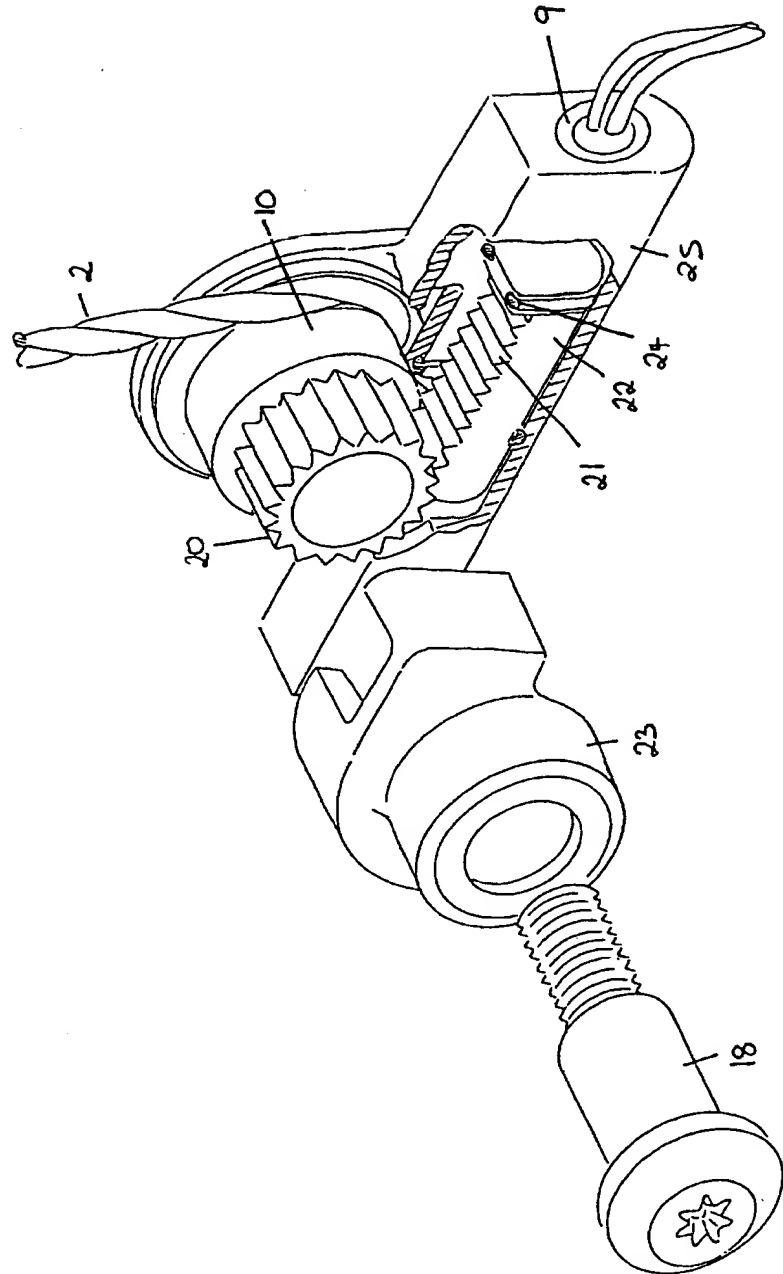
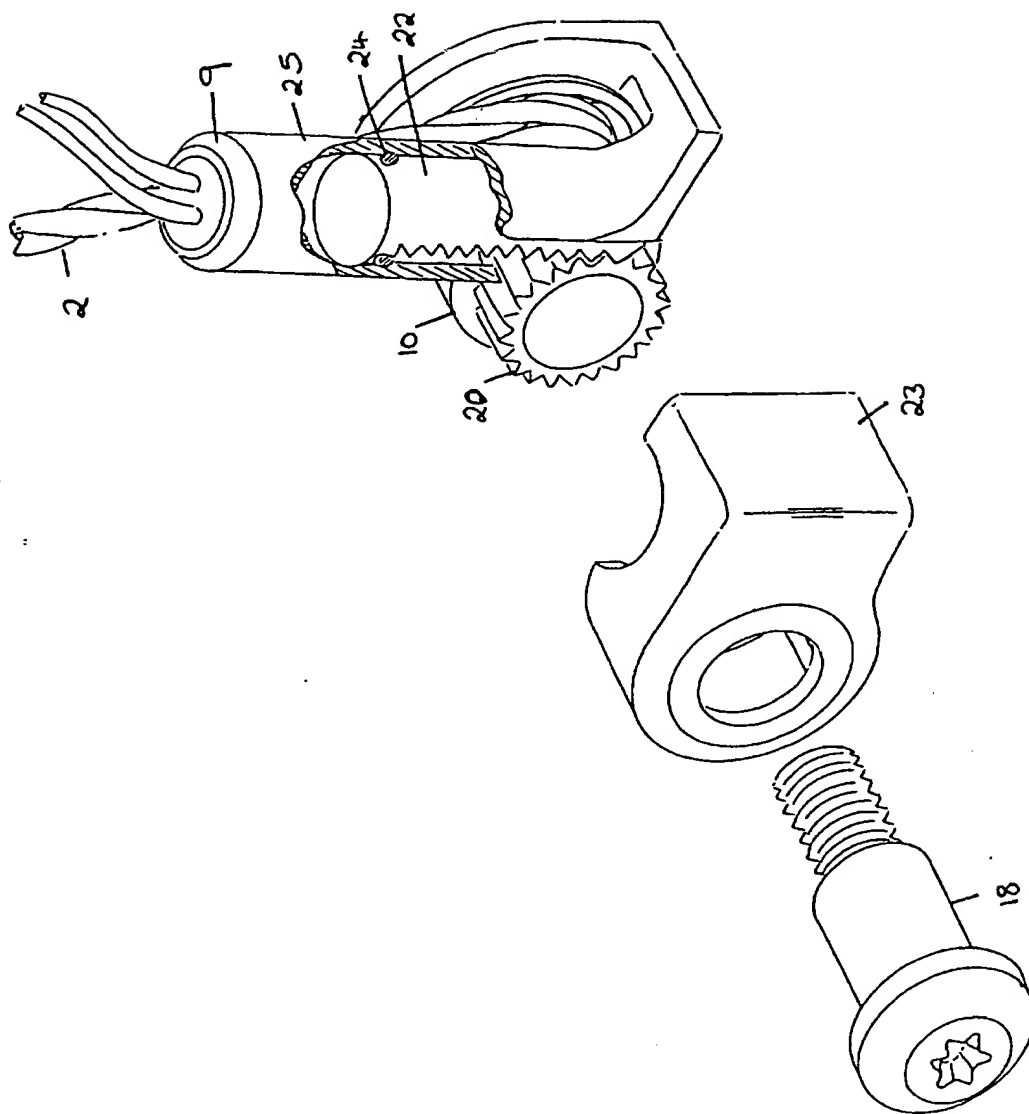


Figure 4



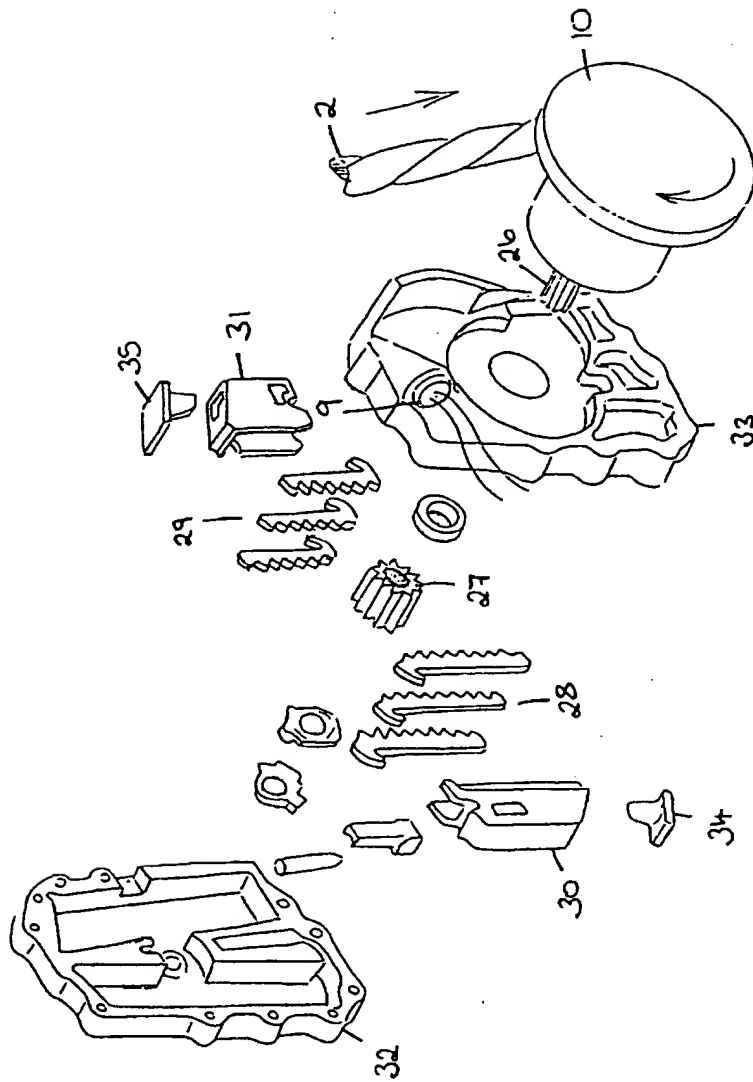


Figure 5

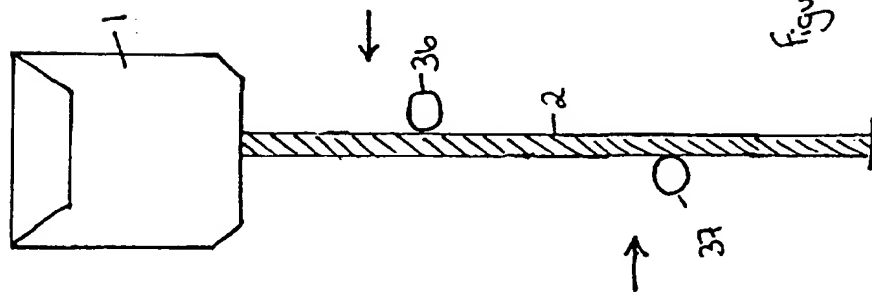


Figure 6A

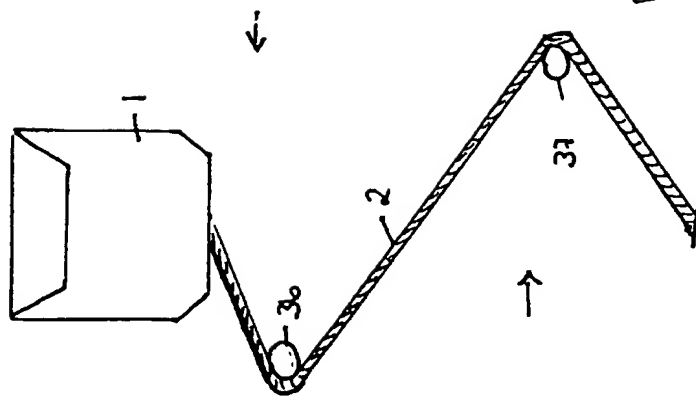


Figure 6B

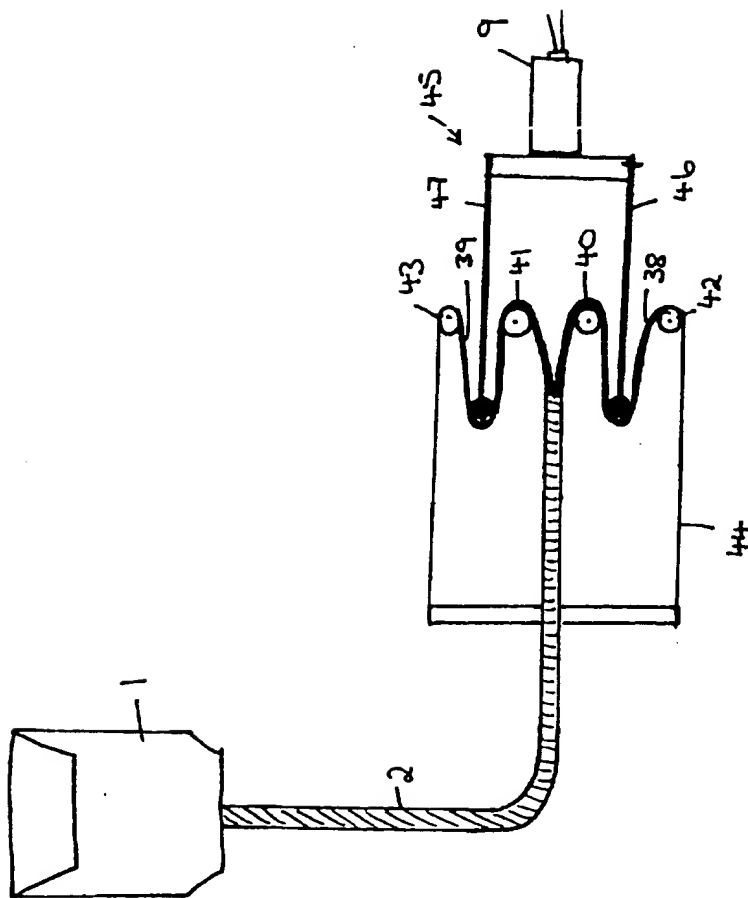
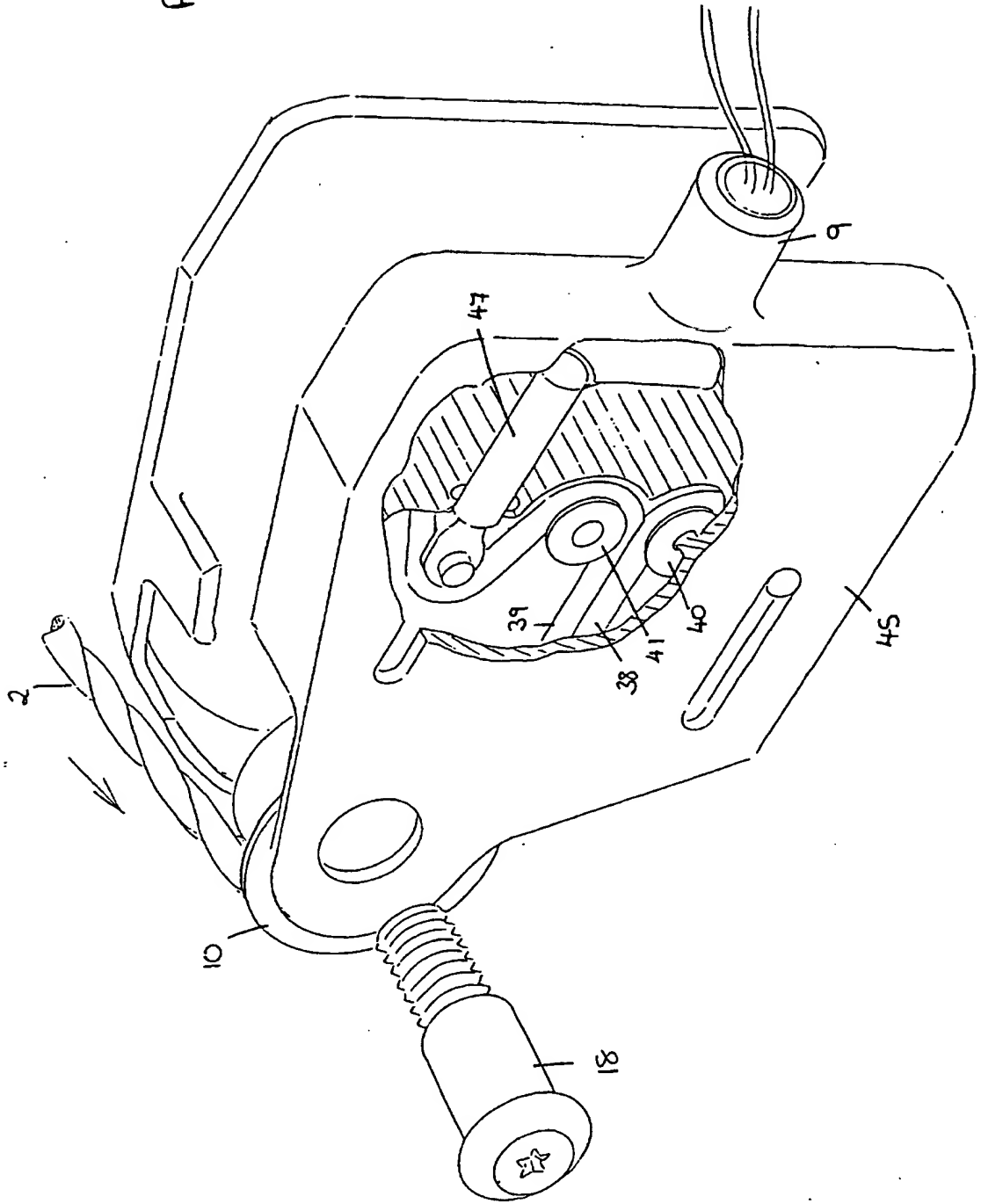


Figure 7A

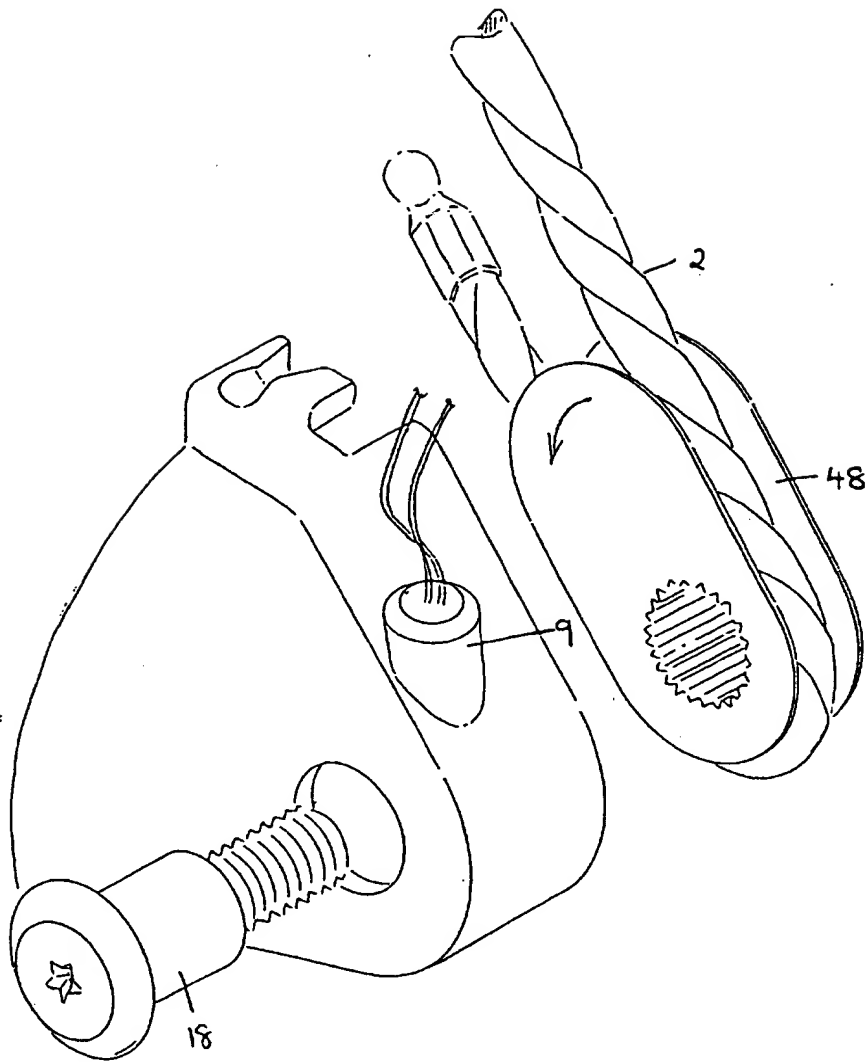


Figure 7B



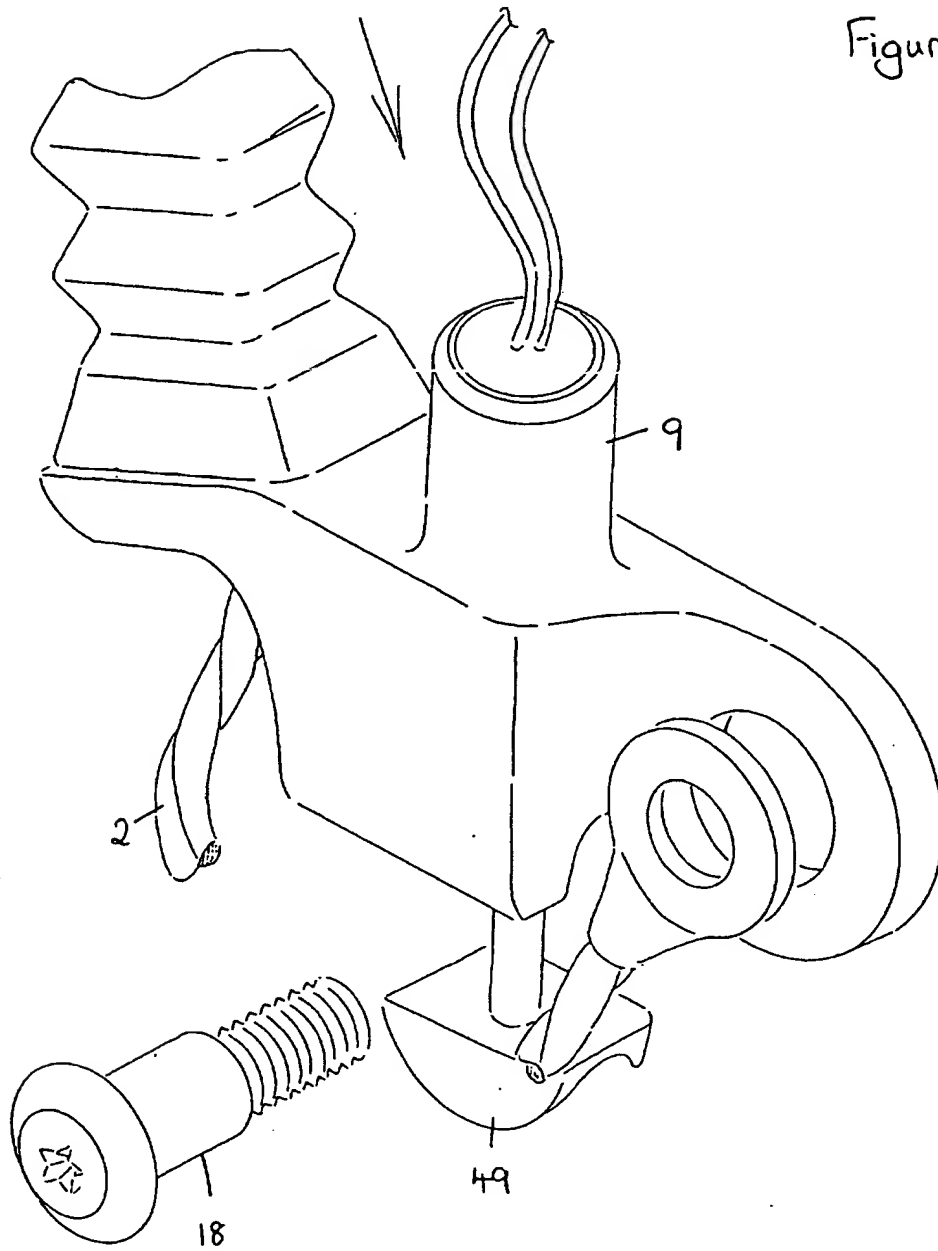
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Figure 8



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Figure 9



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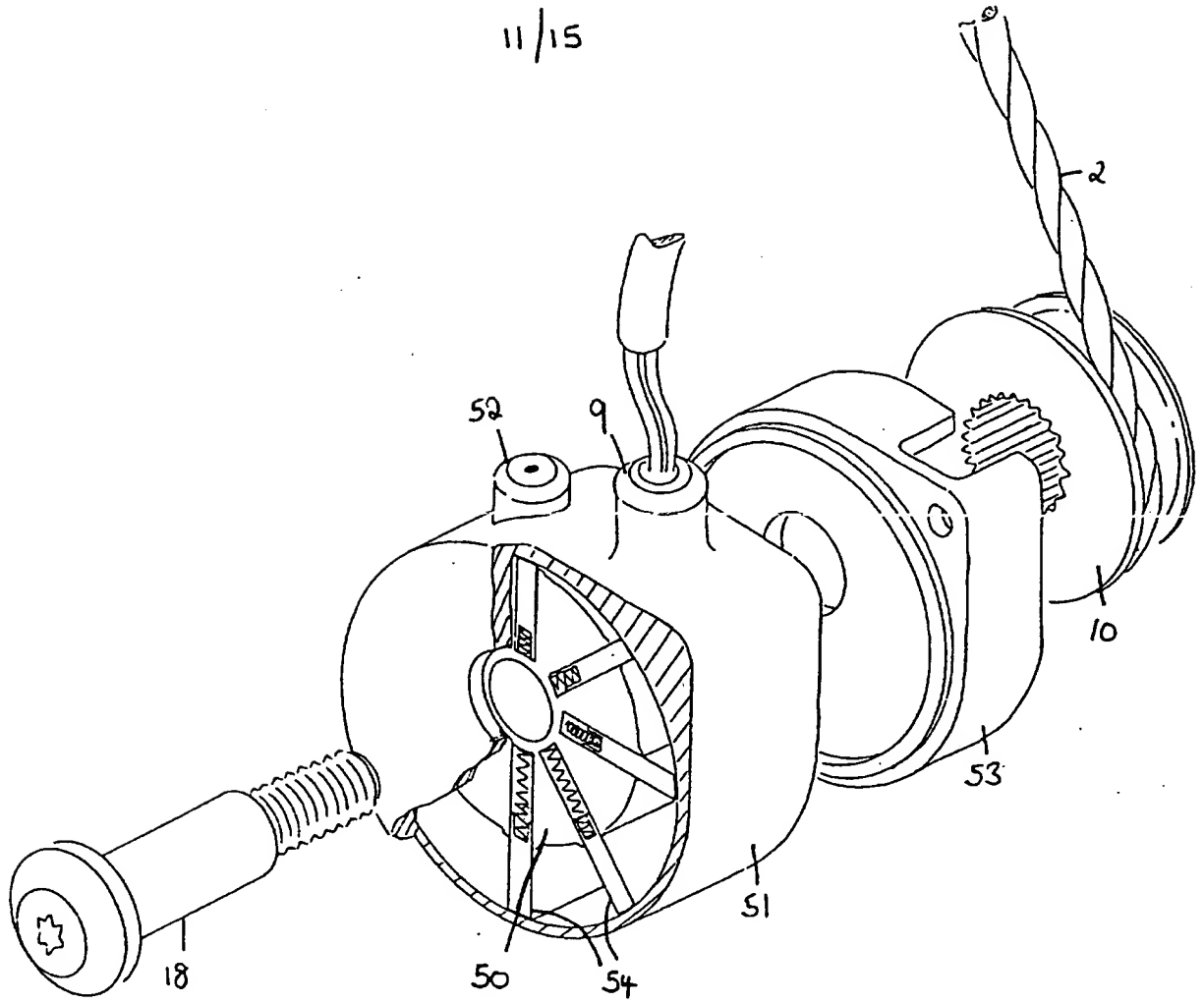


Figure 10

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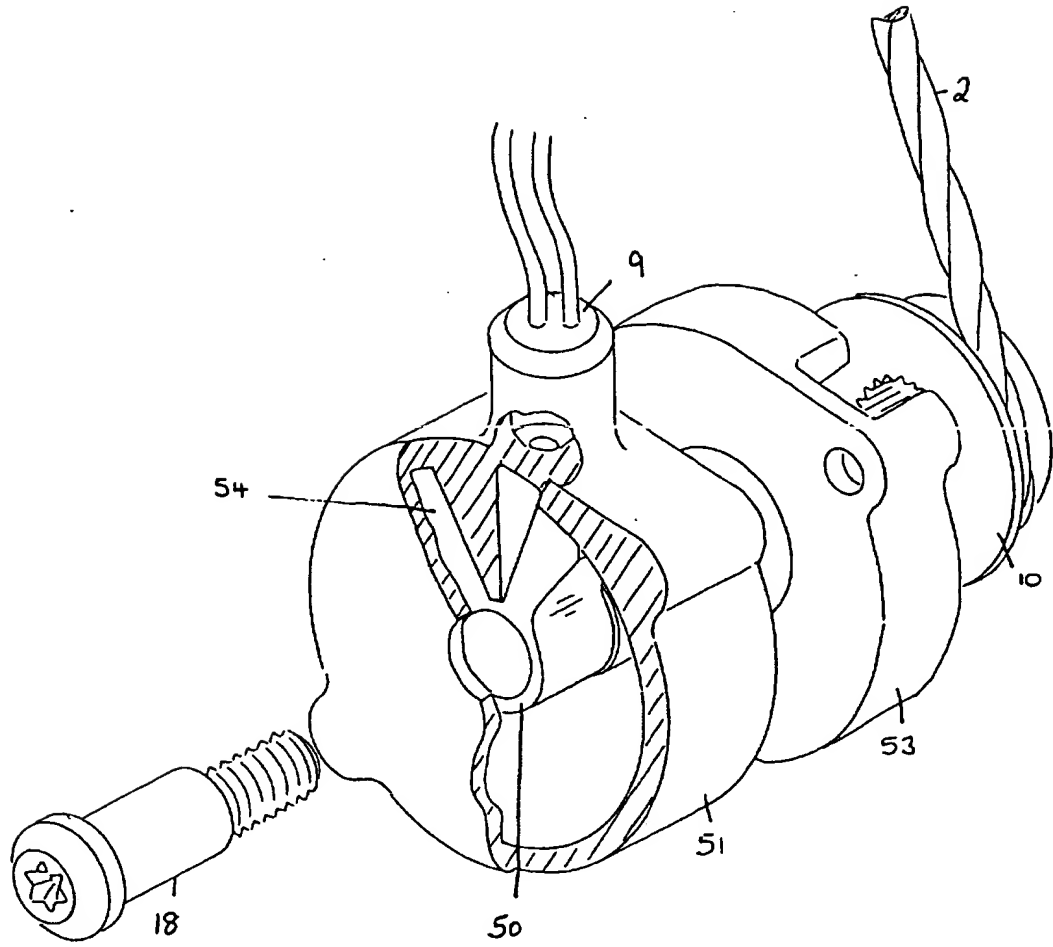


Figure 11.

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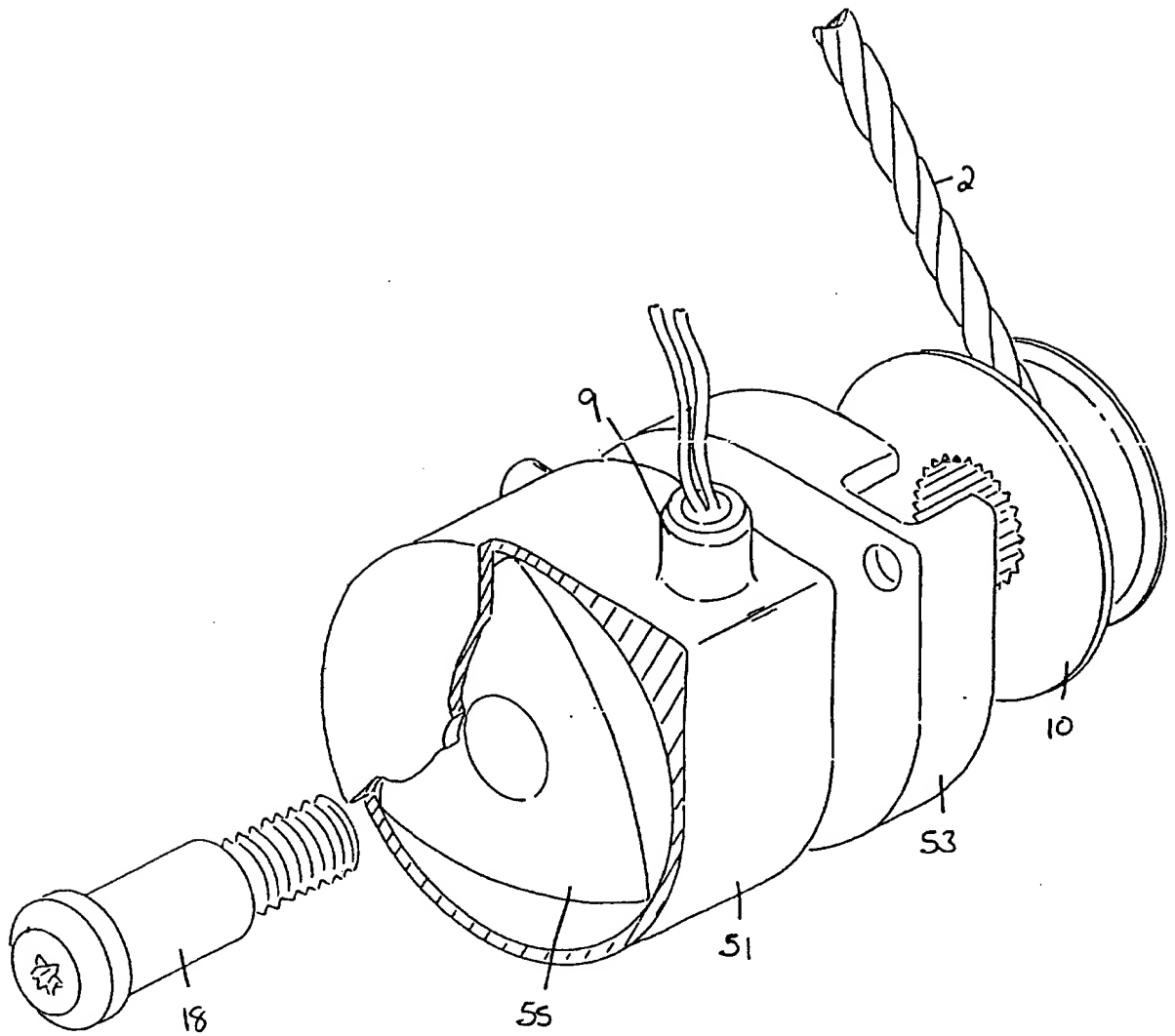
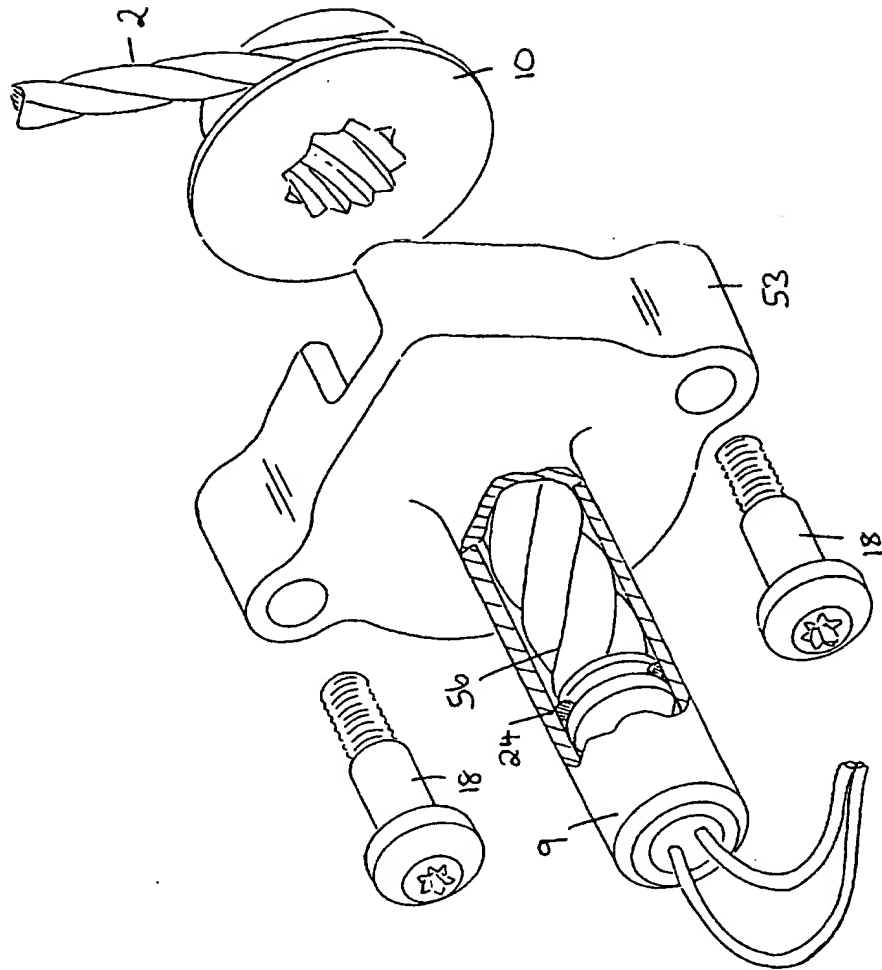


Figure 12

Figure 13



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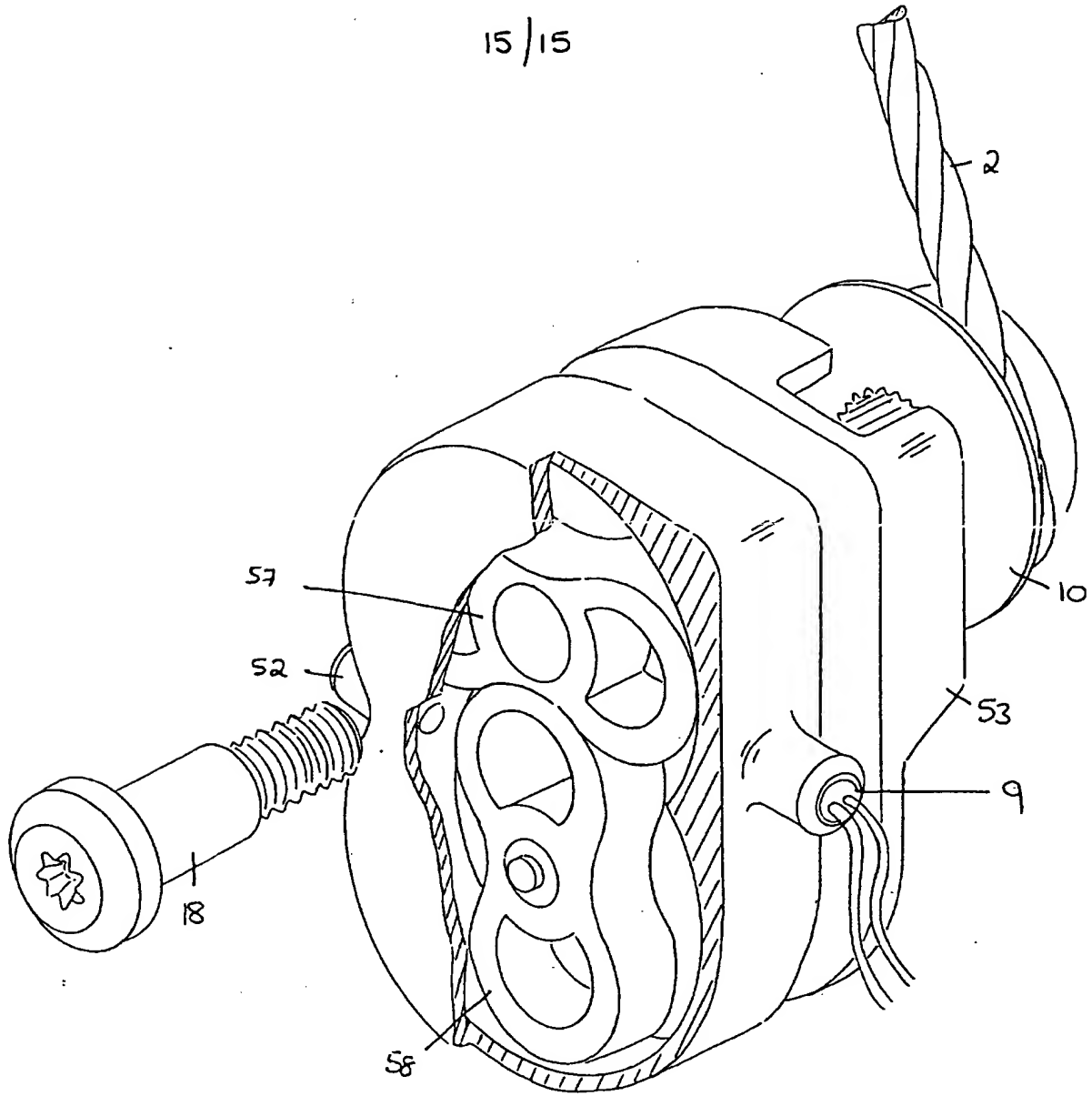


Figure 14



DESCRIPTIONBUCKLE PRETENSIONER

The present invention relates to a buckle pretensioner  
5 for a vehicle safety restraint.

Pretensioners are used to rapidly withdraw a length of  
seat belt webbing in the event of an emergency. This takes  
up slack in the seat belt which might be caused by bulky  
10 clothing or by a vehicle occupant being out of position such  
as when leaning forward in the seat, or when seated skewed  
for example when asleep. The purpose of eliminating this  
slack is to more securely restrain the vehicle occupant at  
the onset of emergency conditions, and to more correctly  
15 position him for maximum effect of any secondary safety  
restraint such as an airbag.

Pretensioners may be sited at the retractor end of a  
three-point safety belt to rapidly rewind the belt webbing,  
20 or alternatively at the buckle end to rapidly pull back the  
buckle mounting.

Known buckle pretensioners use a piston-cylinder  
arrangement in which a piston connected to the buckle  
25 mounting is pushed rapidly along a cylinder by the force of  
a spring or more recently by pyrotechnic means which release  
a sudden rush of gas. Such arrangements are bulky and  
difficult to fit unobtrusively in a vehicle, particularly in  
the smaller models of vehicle which are popular nowadays.

30

It is an object of the present invention to provide an

improved buckle pretensioner and particularly a more compact design.

According to the present invention there is provided a  
5 buckle pretensioner for a vehicle safety restraint  
comprising a buckle head for receiving a buckle tongue to  
secure safety restraint webbing about a vehicle occupant in  
a three-point belt system, the pretensioner comprising; a  
10 cable connected to the buckle head and means for rapidly  
withdrawing the cable in a belt tightening direction, the  
withdrawing means comprising a force reservoir and driving  
means and being more compact than hitherto known.

According to a first embodiment of the invention the  
15 pretensioner further comprises step-up gearing means for  
converting a linear movement of a predetermined magnitude,  
produced by the force reservoir, into a linear movement of  
the cable of more than the predetermined magnitude,  
preferably a multiple of the predetermined magnitude.

20

Gearing arrangements were not previously considered  
viable for pretensioners, particularly buckle mounted  
pretensioners because they increase the torque which must be  
generated by the driving means, the maximum torque from  
25 traditional driving means was limited. However the  
improvements in pyrotechnic force reservoirs means that  
sufficient torque can now be generated rapidly enough.

The step-up gearing may comprise a multiple pulley  
30 arrangement, such that the withdrawal means operates on a  
small diameter pulley fixedly connected to rotate with a

large diameter pulley about which the cable is wound.

This arrangement allows a relatively simple force reservoir to be used in the pretensioner because the  
5 necessary locking devices can be included in the pulley arrangement, for example a simple ratchet and stop, rather than being part of the force reservoir (for example in the tube of a piston-cylinder pretensioner) as hitherto.

10 This embodiment can also be adapted relatively easily to incorporate load limiting features.

It is particularly applicable to the use of a piston-cylinder type pretensioner, either with a spring or a  
15 pyrotechnic force reservoir and the cylinder tube can in this case be made much shorter than in previous pretensioners.

However this embodiment is equally applicable to other  
20 types of force reservoir or to other driving means.

According to a second embodiment the driving means comprises a rack and pinion arrangement. The rack may be vertical or horizontal and is driven past the pinion wheel  
25 which is connected to rotate a pulley about which the cable is wound, by spring force or by a gas generator.

The pinion wheel may be driven by more than one rack, as for example in a system with two moving racks one on  
30 either side of the pinion wheel in opposite directions to reinforce each other's driving force. Their movement may be

synchronised or phased depending on the pretensioning characteristics to be achieved.

Force reservoirs such as gas generator may be integral  
5 with the racks.

Gearing arrangements may advantageously also be incorporated in this embodiment.

10 According to a third embodiment, the driving means comprises at least two pulley wheels across which the cable passes and means for extending the distance between the pulley wheels so as to withdraw the cable in the belt tightening direction.

15 Two pulley wheels may be arranged adjacent the path of the cable and driven in opposite directions across the path of the cable so as to withdraw the buckle head.

Alternatively two or preferably more pulley wheels are  
20 arranged with the buckle cable wound around them in an S configuration and one or more pulley wheels are driven parallel to the cable to withdraw the buckle head.

A further alternative is to use an elongate, elliptical  
25 or oval, cam pulley, arranged in normal use with the cable passing along both its long sides and round one of its short sides. Under pretensioning conditions this cam pulley is rotated rapidly through approximately  $90^\circ$  so that its long sides are tangential to the path of the cable from the  
30 buckle head, thus quickly and easily shortening the effective length of cable from the buckle head to its

mounting position. The cam pulley may be driven by a pyrotechnically detonated gas generator or by a spring, or by other force reservoir means.

5 A gas generator driven cam faced piston may be used instead. The buckle cable passes over the outer arcuate cam face of the piston. When pretensioning is required the gas generator drives the piston a predetermined distance away from the buckle head and thus shortens the effective length  
10 of the cable to the buckle head.

According to a fourth embodiment of the invention the driving means comprises a rotating part with paddles or vanes driven by gas from a gas generator. This may be a  
15 wheel connected to the cable pulley, with or without gearing, or a helix coaxial with the cable pulley.

Alternatively a Roots motor or gear pump could be used comprising two camming figure-of-8 drive parts, one driven  
20 by a gas generator, the other coaxial with the cable pulley.

For a better understanding of the present invention and to show how the same may be carried into effect, reference will now be made to the accompanying drawings, in which:  
25

Figure 1 is a schematic view of a compact buckle pretensioner according to one embodiment of the invention.

30 Figure 2 is an exploded view of a buckle pretensioner according to a variant of the embodiment of Figure

1.

Figures 3 and 4 are exploded views of a second embodiment of the present invention.

5

Figure 5 is an exploded view of the buckle pretensioner according to a variation of the second embodiment of the present invention.

10

Figure 6 is a schematic cross-sectional view of a buckle pretensioner according to a third embodiment of the present invention.

15

Figure 7 is a part cut-away view of a buckle pretensioner according to a variant of the third embodiment.

20

Figure 8 is an exploded view of a buckle pretensioner according to another variant of the third embodiment.

25

Figure 9 illustrates another variant of a buckle pretensioner according to the third embodiment.

Figure 10 is an exploded, and part cut-away view of a buckle pretensioner according to a fourth embodiment of the invention.

30

Figures 11, 12, 13 and 14 show alternative variants of the fourth embodiment of the invention.

In Figure 1 there is shown a buckle head 1 connected by a cable 2 to the outer diameter of a large diameter pulley wheel 3. Normally the cable would be covered with a plastic sheath and the buckle head is supported to be upstanding by a relatively stiff stalk but these are not shown in Figure 1. The pulley wheel 3 is attached to a smaller diameter pulley wheel 4 and the outer diameter of this is connected by cable 5 to piston 6 of pretensioner 7. Piston 6 is arranged for sliding movement in the cylinder 8 and a gas generator 9 is arranged to be electrically detonated in the event of a crash being detected by crash sensors to release gas into the cylinder 8 to push piston 6 in the direction of arrow A. This has the advantage over traditional arrangements of providing a step up gearing of a ratio corresponding to the ratios of the circumferences of the two pulley wheels 3 and 4. Thus movement of the piston a predetermined length along the cylinder 8 will move the buckle head downwards by a larger length depending upon the gearing ratio. Thus a more compact linear pretensioner can be used.

Figure 2 illustrates a load limiting arrangement in a compact buckle pretensioner. The buckle cable 2 passes from the buckle (not shown) around pulley wheel 10. One side of the wheel 10 is provided with sloping teeth which face correspondingly shaped sloping teeth 12 on the side of a locking ratchet 13 which has locking teeth 14 on its outer circumference. The locking teeth 14 can be engaged by locking pawl 15 which is rotatably mounted on the casing of a buckle pretensioner 16. The locking ratchet 13 and pulley wheel 10 are mounted on and coaxial with drive shaft 17 of

the compact pretensioner 16. They are fixed on the drive shaft 17 by a bolt or rivet 18 and a spring clutch arrangement 19 is mounted between the rivet 18 and the pulley wheel 10. The pretensioner 16 is fired by 5 electrically detonated gas generator 9. However, other firing means may be used.

Spring 19 acts on pulley wheel 10 to keep it engaged, via the interlocking sloping teeth 11 and 12, with the 10 locking ratchet 13 up to a predetermined torque. Above the predetermined torque the sloping teeth 11 and 12 slip over each other and allow the pulley wheel 10 to rotate independently of the locking ratchet 13. Thus a maximum load is applied to the vehicle occupant restrained by this 15 buckle.

Figure 3 shows an alternative compact buckle pretensioner. The buckle head (not shown) is again connected via cable 2 to a pulley wheel 10. One section of 20 the pulley wheel 10 has teeth 20 about its outer circumference. These teeth are engaged by corresponding teeth 21 on a horizontal rack 22 which is driven tangential to the pulley wheel 10 by electrically detonated gas generator 9. The pulley wheel 10 is protected by an outer 25 cover 23 and is mounted for rotation and secured in place by rivet or bolt 18.

Figure 4 shows an alternative arrangement to Figure 3 in which the rack 22 is vertically mounted. Otherwise like 30 parts are denoted by like reference numbers. In Figures 3 and 4 a seal 24 is situated between the rack 22 and



pretensioner housing wall 25. This maximises the effect of the gas generator by preventing escape of gas along the side of the rack. In addition a locking means is provided so as to lock the rack and pinion in the pretensioned state after  
5 pretensioning to hold the buckle in the retracted position. This may, for example be, in the form of a locking ellipse as is well known in this field and as is shown in GB 1 351 447 and also is described in DE 42 34 132.

10 Figure 5 shows an alternative compact buckle pretensioner. Again buckle cable 2 is connected to a pulley wheel 10 mounted on shaft 26. A tooth pinion wheel 27 is mounted on shaft 26. Two sets of tooth racks are arranged one on either side of the pinion wheel 27 so that when  
15 activated they move across the pinion wheel engaging the teeth and rotating it. The racks 28 and 29 are mounted on respective support blocks 30, 31 and the parts are contained within housing parts 32, 33. An electrically detonated gas generator 9 acts to push the support blocks 30, 31 with  
20 their respective racks 28, 29 along the respective channels formed by the two parts of the covers 32, 33. The gas from the gas generator 9 pushes support members 30 and 31 by acting on planer surfaces of the support end members 34, 35.

25 Figure 6 illustrates another embodiment of the invention. In Figure 6a the buckle is shown in the normal use condition. In Figure 6b the pretensioner has operated and the buckle head 2 has been retracted. This is effected by driving two rods 36 and 37 in opposite directions across  
30 the path of the cable 2 as indicated by the arrows.

Figure 7 shows a similar arrangement in which multiple pulleys are introduced and the rods are pushed in a direction parallel to the buckle cable 2. This arrangement is even more compact than that of Figure 6a and 6b. Figure 5 7a is a schematic diagram showing buckle head 1 attached via cable 2 to split cables 38, 39 which pass over respective pulley wheels 40, 41 and are fixed at points 42, 43 to the pretensioner housing 44. A drive arrangement 45 comprises two pusher fingers 46 and 47 which act on respective split 10 cables 38, 39. An electrically detonated gas generator 9 or other drive means acts on the outer planer face of the pusher member 45 to drive it in the direction of the arrow thus pulling in a predetermined length of buckle cable 2 to retract the buckle head 1. This same arrangement is shown 15 in Figure 7b in part cut-away cross-sectional view where like references denote like parts.

Figure 8 shows a similar arrangement in which the buckle cable 2 passes around an elliptic cam 48. The 20 pretensioner drive means, such as electrically detonated gas generator 9, rotates this cam 48 in the direction of the arrow so as to take up a predetermined length of cable 2 and thus retract the buckle head.

25 Figure 9 uses a pusher member 49, driven by gas generator 9 to take up a length of cable 2.

Figure 10 shows an embodiment which uses a vane motor 50 as a pretensioning drive force. The vane motor 50 is 30 contained within a housing 51 and is driven by electrically detonated gas generator 9. An exhaust port 52 is provided

in the housing 51. The vane motor 50 is mounted for rotation via the fixing screw 18 which also passes through the motor drum casing 53 and a cable pulley wheel or winch drum 10 about which the buckle cable 2 passes.

5

Figure 11 shows a variation of this vane motor which has a single paddle 54 instead of multiple paddles as in Figure 10.

10 In Figure 12 another variation is shown using a tri-lobe motor 55 in housing 51. Again this is driven by electrically detonated gas generator 9, though the person skilled in the art will see that there are many satisfactory alternative drive means.

15

Figure 13 shows a screw driven buckle pretensioner in which a helical drive shaft 56 is rotated by the force from electrically detonated gas generator 9. Seals 24 assist the gas generator 9 in operating efficiently. Preferably the  
20 pulley wheel on winch drum 10 has reverse locking.

Figure 14 is an embodiment using a rotor drive or a Roots motor. This comprises two figure-of-8 rotors 57, 58. The drive rotor 57 is mounted for rotation about fixing  
25 screw 18 which also fixes the winch drum 10 about which buckle cable 2 is wound. The idler rotor 58 is driven by gas generator 9 and this drives the drive rotor 57 and consequently winch drum 10 to pull back the buckle cable 2 and thus the buckle head (not shown).

30

It will be seen in all these examples that the buckle

pretensioner is particularly compact and suitable for siting in convenient and unobtrusive positions in a vehicle close to the buckle head, or at a distance as required by the vehicle manufacturer.

CLAIMS

1. A buckle pretensioner for a vehicle safety restraint comprising  
5 a buckle head for receiving a buckle tongue to secure safety restraint webbing about a vehicle occupant in a three-point belt system;  
a cable connected to the buckle head; and  
means for rapidly withdrawing the cable in a belt  
10 tightening direction,  
the withdrawing means comprising  
a force reservoir, and  
driving means, and  
being of a compact construction.  
15
2. A buckle pretensioner according to claim 1 further comprising step-up gearing means for converting a linear movement of a predetermined magnitude, produced by the force reservoir, into a linear movement of the cable of more than  
20 the predetermined magnitude.
3. A buckle pretensioner according to claim 2 wherein the linear movement of the cable is a multiple of the predetermined magnitude.  
25
4. A buckle pretensioner according to any preceding claim wherein the force reservoir comprises pyrotechnic means.
- 30 5. A buckle pretensioner according to claim 9 wherein the force reservoir comprises a spring.

6. A buckle pretensioner according to any one of claims 2 to 4 wherein the step-up gearing comprises a multiple pulley arrangement, comprising a small diameter pulley and a large diameter pulley, fixedly connected to rotate together, and wherein the withdrawal means is connected to operate on the small diameter pulley and the cable passes over the large diameter pulley.

10 7. A buckle pretensioner according to claim 6 comprising a locking device for preventing reverse movement of the withdrawing means, which locking device is located in the pulley arrangement.

15 8. A buckle pretensioner according to claim 7 wherein the locking device comprises a ratchet and stop.

9. A buckle pretensioner according to any preceding claim further comprising load limiting means.

20

10. A buckle pretensioner according to any preceding claim wherein the pretensioner driving means comprises a piston-cylinder arrangement.

25 11. A buckle pretensioner according to any one of claims 1 to 9 wherein the driving means comprises a rack movable translationally to contact and turn a pinion wheel.

30 12. A buckle pretensioner according to claim 11 wherein the rack is generally vertically oriented and movable generally vertically past the pinion wheel.

13. A buckle pretensioner according to claim 11 wherein the rack is generally horizontally oriented and movable generally horizontally past the pinion wheel.

5 14. A buckle pretensioner according to any one of claims 11 to 13 comprising a plurality of racks arranged to contact and move the pinion wheel.

10 15. A buckle pretensioner according to claim 14 comprising two movable racks arranged one on either side of the pinion wheel and movable in opposite directions to reinforce each other's driving force.

15 16. A buckle pretensioner according to claim 15 wherein the movement of the two racks is synchronised or phased depending on the pretensioning characteristics to be achieved.

20 17. A buckle pretensioner according to any one of claims 11 to 16 wherein the force generator is integral with the or at least one of the racks.

25 18. A buckle pretensioner according to any one of claims 11 to 17 further comprising a gearing arrangement.

30 19. A buckle pretensioner according to any one of claims 11 to 18 wherein the driving means comprises at least two pulley wheels across which the cable passes, and means for extending the distance between the pulley wheels so as to withdraw the cable in the belt tightening direction.

20. A buckle pretensioner according to any one of claims 11 to 19 comprising a plurality of pulley wheels arranged with the buckle cable wound around them in an S configuration and one or more pulley wheels which are driven parallel to the cable to withdraw the buckle head.

21. A buckle pretensioner according to any one of claims 11 to 20 comprising an elongate, elliptical or oval, cam pulley, arranged in normal use with the cable passing along both its long sides and round one of its short sides so that under pretensioning conditions the elongate cam pulley is rotated rapidly through approximately 90° so that its long sides are tangential to the path of the cable from the buckle head, thus quickly and easily shortening the effective length of cable from the buckle head to its mounting position.

22. A buckle pretensioner according to any one of claims 11 to 21 comprising a gas generator driven cam faced piston arranged so that the buckle cable passes over the outer arcuate cam face of the piston.

23. A buckle pretensioner according to any one of the preceding claims wherein the driving means comprises a rotating part with paddles or vanes driven by gas from a gas generator, and the rotating part comprises a wheel connected to the cable pulley, or a helix coaxial with the cable pulley.

24. A buckle pretensioner according to any one of the preceding claims comprising a Roots motor or gear pump



comprising two camming figure-of-8 drive parts, one driven by a gas generator, the other coaxial with the cable pulley.

25. A buckle pretensioner substantially as  
5 hereinbefore described with reference to Figures 1 and 2, or Figures 3 to 5, or to Figures 6 to 9, or to Figures 10 to 14, of the accompanying drawings.



Application No: GB 9711348.4  
Claims searched: 1-25

Examiner: Peter Corbett  
Date of search: 11 February 1999

**Patents Act 1977**  
**Search Report under Section 17**

**Databases searched:**

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK CI (Ed.Q): B7B (BVRP)

Int CI (Ed.6): B60R 22/46

Other:

**Documents considered to be relevant:**

Category	Identity of document and relevant passage	Relevant to claims
X,E	GB 2323769 A (AUTOLIV) see Fig 1	1,4
X,E	GB 2320469 A (ALLIEDSIGNAL) see Fig	1,4,5
X,E	GB 2315986 A (ALLIEDSIGNAL) see Fig 1	1,4,10
X	GB 2297238 A (TOKAI) see Fig 1	1-4,10
X	GB 2250418 A (AUTOLIV) see Fig 1	1,5
X	GB 2247392 A (GENERAL ENGINEERING) see Fig	1,5
X	GB 2227642 A (AUTOLIV) see Fig 1	1,5
X	WO 97/39923 A1 (TRW) see Fig 1	1,4,10

X Document indicating lack of novelty or inventive step  
Y Document indicating lack of inventive step if combined with one or more other documents of same category.

& Member of the same patent family

A Document indicating technological background and/or state of the art.  
P Document published on or after the declared priority date but before the filing date of this invention.  
E Patent document published on or after, but with priority date earlier than, the filing date of this application.